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Production of Bioethanol from Bulrush with Process Hydrolysis, Fermentation and Batch Distillation

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Abstract

Bulrush is an alternative raw material to produce bioethanol, through acid hydrolysis process, fermentation and batch distillation. Bulrush avaibility can be obtained continuesly and abundantly, representing one of the crops which less is exploited. Bulrush is only used as livestock food, sometimes it is olso considered to be an intruder crop. But bulrush has cellulose content which can be used as one of the materials which produces ethanol. Up to now the word ethanol consumption has been about 63 % for fuel, especially in Brazil, North America, Canada, United Europe and Australia. In Asia, Japan and South Korea the biggest ethanol consumption is for liquor.

Hydrolysis process in this reseach used constant condition: temperature 30 ^{o}C, water volume 700 ml, reseach variable: hydrolysis time 2 until 3 hours, bulrush weights 50, 100, 150, 200, 250 (gram), volume HCl 10, 20, 30, 40, 50(ml). Fermentation process in this reseach used constant condition: temperature 20 up to 30 ^{o}C, pH 4, 5 ; filtrate volume 250 ml, reseach variable: 4, 5, 6, 7, 8 days; and starter 8, 10, 12 %. Pure ethanol product was obtained by batch distillation process. This research resulted in hydrolysis process has the best glucose content 26.29 %, dry bulrush weight 200 gram, and HCl volume 20 ml. Fermentation process has saccaromyces cerevisiae starter content 10 % during 6 days, ethanol yields 9 up to 12 % before distillation process, residu glucose content 8.09 % and after distillation process ethanol yields 96 %. From the research result which was obtain, it can be concluded that: bulrush can be used as an alternative which produces bioethanol.

1. Introduction

Ethanol or ethyl alcohol sometime referred as also ethanol spiritus, ethanol used in industrial immeasurable like mixture for the liquor of like sake or gin, raw material of pharmacy and cosmetic, fuel mixture, more octane and gasoline ethanol (gasohol). To date consume the ethanol world of about 63 percent for the fuel, especially in Brazil, North America, Canada, United Europe, and Australia. In Asia, Japan and South Korea the biggest ethanol consumption is for liquor. Ethanol's functions as fuel mixture have the good prospect because price of crude oil more and more high. This ethanol function as adder of volume fuel, as more octane number and oxygen source for the combustion cleaner of Methyl Tertiary Butyl Ether (MTBE) substitution. Because ethanol contain 35 percent oxygen, can improve the combustion efficiency, it is also environmental friendliness because gas emission throw away the low degree carbon monoxide, nitrogen oxide and glasshouse gas becoming pollutant also easy to raveled and peaceful because do not contaminate environment.

Obtainable ethanol from various agricultural produce substances, in general the substance divided into three kinds that is: first, pregnant substance of sugar generation as first faction for example molasses, cane sugar, beet sugar and juice. Second, pregnant substance extract of like bulk (grist, potato, tapioca). Third, substance that contain of cellulose (wood and some agriculture waste). Three, pregnant substance monosaccharide ($C_6H_{12}O_6$) as direct glucose ear the fermentation ethanol, however disaccharide, complex carbohydrate have to hydrolyzed beforehand become the simple component in the form of monosaccharide. Disaccharide like sand sugar ($C_{12}H_{22}O_{11}$) have to hydrolyze become the glucose, polysaccharide like cellulose have to be altered beforehand become

the glucose, chemically process the long ambulatory ferment enough, because happen a reaction row which is each influenced by special enzyme.

Bulrush represents the annual crop upstanding, taking root in and high with slender short, high stem can reach 2-4 meter (even reach 6-7 meter), with stem diameter can reach more than 3 cm and composed until 20 space. Grow to form the clump widely is clump till 1 meter. Short furry hairless leaf frond till, leaf piece mark with lines under color of wide, its back part become sharp the nutrient content each, every dry substance ton is N: 10-30 kg, P: 2-3 kg, K: 30 kg, Ca: 3-6 kg, Mg and S: 2-3 kg. Obstetrical differ from bulrush is : harsh protein 5,20 percent ; harsh fiber : 40,85 percent ; glucose: 2,84 percent ; water: 43,61 percent (Laboratory of Instrumentation UPN " Veteran" east java).

Cellulose is polymer alpha-glucose with the tying beta 1 until 4 among set of its glucose, cellulose function upon which structure in plant network in the form mixture polymer homolog and usually accompanied the polysaccharide other dissimilar and immeasurable lignin in number. Cellulose represents the polysaccharide a lot of under the sun can be turned into glucose by hydrolysis acid. Hydrolysis acid is hydrolysis with used acid can alter the polysaccharide (extract, cellulose) becoming sugar, in hydrolysis acid usually used chloride acid (HCl) or sulphate acid (H_2SO_4) with the certain stem. This hydrolysis usually in made special tank from rustproof steel or copper which attributed to pipe channel heater and air intake to arrange the pressure in air cell khamir is microorganism have single cell of the size between: 5-20 micron, fairish usually until 5-10 cross bigger than bacterium, there are assorted form the yeast, and this form of depend on its bisection. Cell khamir often met in single cell, but if cell children not discharged from its mains after bisection, hence will be happened the form so-called pseudomiselum. Motion less khamir, bisection khamir happened by asexual or shoot.

Fermentation process taken is ferment process do not use the oxygen or anaerobe process, arrangement way produce the ethanol from sugar enough complex, concentration substrata, oxygen, and product ethanol, all influencing metabolism khamir, energy live the cell, cell growth, cell bisection, and produce the ethanol. Select the compatible gaur khamir and have the high tolerance to concentration, substrata and alcohol, representing important matter to the make-up of result.

2. Theory

Cellulose from grass can be turned into ethanol with the sour hydrolysis process with the certain rate, process the cellulose hydrolysis must be done with the acid concentrated can yield the glucose (Fiesser dan Fisser, 1963). Process this hydrolysis influenced by some factor, among other things: pH influence the hydrolysis process so that can be yielded a hydrolysis matching with wanted, pH which is good to hydrolysis process is 2.3 (Soebijanto, 1986). Temperature also influence the speed process react the hydrolysis, temperature which is good to cellulose hydrolysis about 21^oC. Concentration influence fast react the hydrolysis, for the hydrolysis used condensed concentration HCl or condensed H_2SO_4 (Groggins, 1985). In course of cellulose hydrolysis in bulrush turned into glucose with the following reaction:

$$(C_6H_{10}O_5)n + n\ H2O \longrightarrow C_6H_{12}O_6 \quad (1)$$

Glucose Cellulose

Fermentation first time conducted elementary treatment to seed ferment or starter preparation, where starter inoculation until all ready included into ferment (Dwijoseputro, 1982), seed ferment which commonly used saccharomyces cerevisiae. Khamir have the certain growth curve, with the existence of this growth curve knowable hence right time to include the khamir into substrata to ferment. At ferment process, microorganism stand in need of he good nutrias to be obtainable result of good ferment, correct nutrias for the supply of microorganism which nitrogen earn can be from addition NH_3, ammonium salt, peptone, amino sour, urea. Nitrogen required equal to 400-1000 gram/1000 L dilution and phosphate required equal to 400 gram/1000 L dilution (Soebijanto. 1986). Other nutrient is ammonium sulphate with the rate 70-400 gram/100 liter liquid (Judoamidjojo, 1992). pH which is good to bacterium growth is 4.5. At pH 3.5fermentation admit of to walk better and bacterium will be pursued, to arrange the pH can be used condensation of NaOH and HNO3. Temperature which is good to bacterium growth at between: 20-30 ^0C. In course of this ferment, glucose from ferment result turned into [by] ethanol with the following reaction:

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \xrightarrow{\text{Saccharomyces}} \underset{\text{Ethanol}}{2C_2H_5OH + 2CO_2} \quad (2)$$

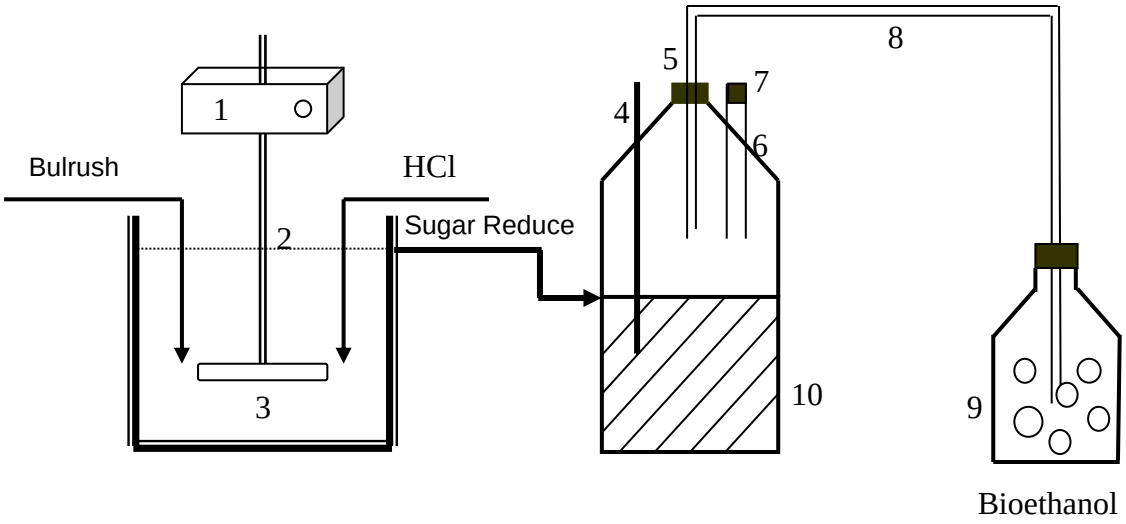

Figure 1: Equipments Hydrolysis and Fermentation Process

Boldness draws:
1. Churn motor
2. Churn impeller
3. Tank
4. Thermometer
5. Close the cork
6. Hole for the nutrient
7. Close
8. Connector pipe
9. Bottle of bioethanol
10. Ferment bottle

Consider the bulrush as heavy as variable which have been run hydrolysis process with condition remain to: temperature 30 ^{0}C, volume of condensation water 7000 ml, time 1 clock. Condition change the bulrush weight: 50, 100, 150, 200, 250 (gram), HCL condensation 10, 20, 30, 40, 50 (ml). Fermentation process with condition remain to: temperature 30 ^{0}C, pH hydrolysis 4.5; filtering the condensation and take the filtrate for to analyzed glucose and look for the best condition to be conducted by ferment. Ferment volume 500 ml; condition change the time: 4, 5, 6, 7, 8 (day); starter: 8, 10, 12 (%); including starter into condensation mentioned in condition anaerobic, later then analyzed bioethanol.

3. Results and Discussion

After got analysis result can be early glucose contain 2.84 %, conducted by a hydrolysis process to break the cellulose which implied in the bulrush become the glucose, analysis result got for glucose contain after hydrolysis shall be as follows: from Figure 2 known that hereafter volume 40 ml tend to happen the stagnation of rate of glucose and degradation of glucose contain. This matter because of too much bulrush included into acid solution of so that hydrolysis bulrush cannot finely. From condition run in course of best glucose contain hydrolysis equal to 37.67 %. Result of this hydrolysis matching with explained by Soebijanto that best pH for the hydrolysis is 2.3, glucose rate used in course of fermentation equal to 26.29 % what obtained from hydrolysis process at pH 4 bulrush weigh equal to 200 gram. This condition selected because optimum glucose contain opened by Sardjoko to process the fermentation equal to 25 %. Glucose as much 26.29 % ferment will with the variation day and sum up the used starter.

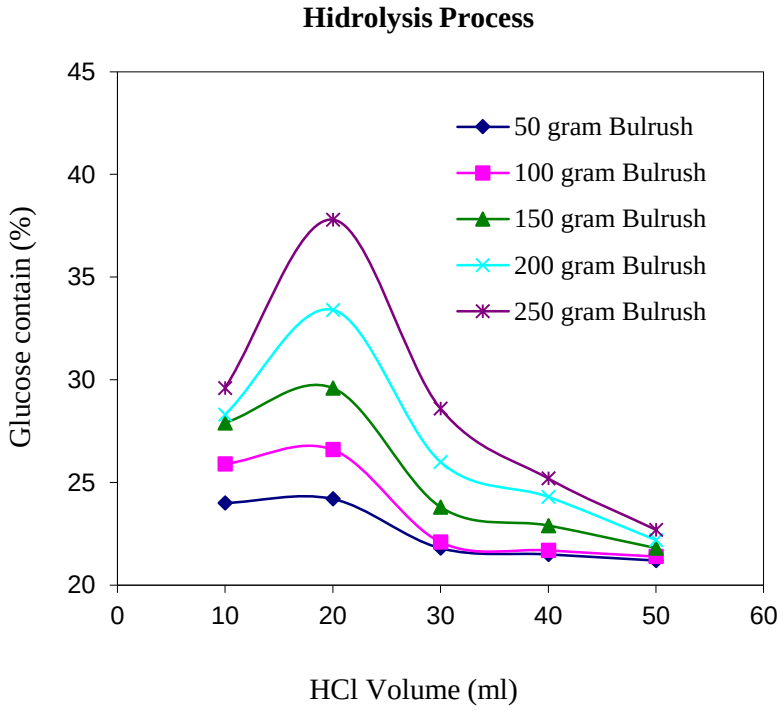

Figure 2: Influence HCl volume and bulrush weight to glucose contain

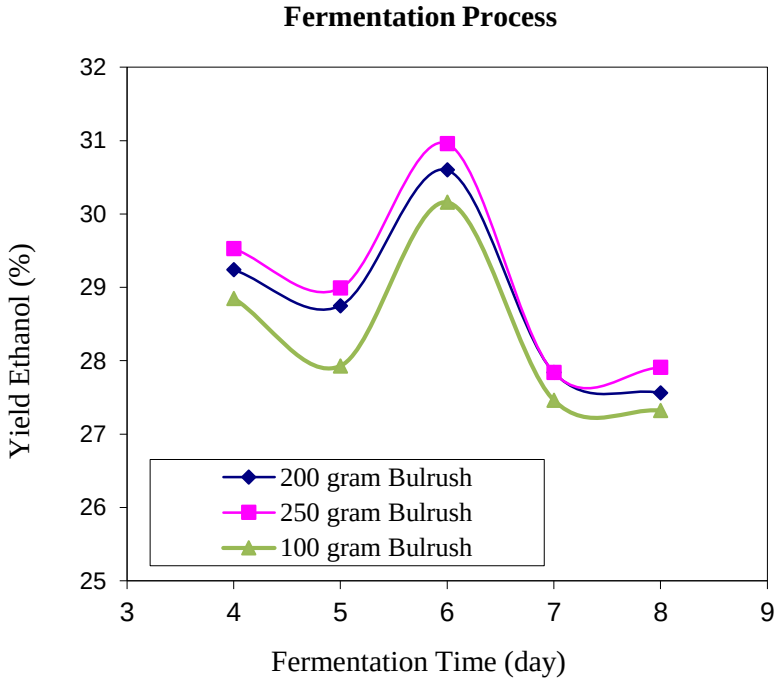

Figure 3: Influence fermentation time and bulrush weight to yield ethanol.

At Figure 3, fermentation time of sixth day, getting the highest composition of ethanol with 12% Saccaromyces Cereviceae. The higher composition of Saccaromyces Cereviceae, the higher composition of ethanol we can get. Time of fermentation from fourth until sixth day, shows the high composition of ethanol. And after six until eight day of fermentation, the

composition of ethanol will decrease, it happens because of a decreasing of Saccaromyces Cereviceae activity.

4. Conclusion

In a hydrolysis process, the weight of bulrush 250 grams and HCl 20 ml, getting 16% glucose contain. In fermentation process, six days fermentation time and 12% Saccaromycess Cereviceae, getting 31.69% yield of ethanol.

References

1. Dwijoseputro, (1982), ”Dasar – Dasar Mikrobiologi”, Djambatan, Malang.
2. Fenger D., (1985), ” KAYU (Kimia Ultrastruktur Reaksi-Reaksi)”, UGM Press Yogyakarta.
3. Fiesser dan Fisser, (1963), ”Pengantar Kimia Organik”, Dhiwantara, Bandung.
4. Ilroy R. J., (1990), ”Pengantar Budidaya Padang Rumput Tropika”.
5. Judoamidjojo, Mulyono, (1992), ”Teknologi Fermentasi”, Rajawali Press Jakarta
6. Kirk Othmer, ”Encyclopedya of Chemical Technology”, Vol. 8, John Wileys nd Sons. Inc.
7. Sardjoko, (1991), “Bioteknologi”, Gramedia, Jakarta.
8. Soebijanto T., (1986), “HFS dan Industri Ubi Kayu Lainnya”, Gramedia Jakarta.